§ 1066.230 Time verification procedure.

(a) *Overview.* This section describes how to verify the accuracy of the dynamometer's timing device.

(b) *Scope and frequency.* Perform this verification upon initial installation and after major maintenance.

(c) *Procedure.* Perform this verification using one of the following procedures:

(1) *WWV method.* You may use the time and frequency signal broadcast by NIST from radio station WWV as the time standard if the trigger for the dynamometer timing circuit has a frequency decoder circuit, as follows:

(i) Contact station WWV by telephone by dialing (303) 499–7111 and listen for the time announcement. Verify that the trigger started the dynamometer timer. Use good engineering judgment to minimize error in receiving the time and frequency signal.

(ii) After at least 1000 seconds, re-dial station WWV and listen for the time announcement. Verify that the trigger stopped the dynamometer timer.

(iii) Compare the measured elapsed time, y_{act}, to the corresponding time standard, y_{ref}, to determine the time error, y_{error}, using the following equation:

$$y_{error} = \frac{y_{act} - y_{ref}}{y_{ref}} \cdot 100\ \%$$

Eq. 1066.230-1

(2) *Ramping method.* You may use an operator-defined ramp function to serve as the time standard as follows:

(i) Set up a signal generator to output a marker voltage at the peak of each ramp to trigger the dynamometer timing circuit. Output the designated marker voltage to start the verification period.

(ii) After at least 1000 seconds, output the designated marker voltage to end the verification period.

(iii) Compare the measured elapsed time between marker signals, y_{act}, to the corresponding time standard, y_{ref}, to determine the time error, y_{error}, using Eq. 1066.230–1.

(3) *Dynamometer coastdown method.* You may use a signal generator to output a known speed ramp signal to the dynamometer controller to serve as the time standard as follows:

(i) Generate upper and lower speed values to trigger the start and stop functions of the coastdown timer circuit. Use the signal generator to start the verification period.

(ii) After at least 1000 seconds, use the signal generator to end the verification period.

(iii) Compare the measured elapsed time between trigger signals, y_{act}, to the corresponding time standard, y_{ref}, to determine the time error, y_{error}, using Eq. 1066.230–1.

(d) *Performance evaluation.* The time error determined in paragraph (c) of this section may not exceed ±0.001%.

§ 1066.235 Speed verification procedure.

(a) *Overview.* This section describes how to verify the accuracy of the dynamometer speed determination. When performing this verification, you must also ensure the dynamometer speed at any devices used to display or record vehicle speed (such as a driver's aid) is representative of the speed input from the dynamometer speed determination.

(b) *Scope and frequency.* Perform this verification upon initial installation, within 370 days before testing, and after major maintenance.

(c) *Procedure.* Use one of the following procedures to verify the accuracy and resolution of the dynamometer speed simulation:

(1) *Pulse method.* Connect a universal frequency counter to the output of the dynamometer's speed-sensing device in

parallel with the signal to the dynamometer controller. The universal frequency counter must be calibrated according to the counter manufacturer's instructions and be capable of measuring with enough accuracy to perform the procedure as specified in this paragraph (c)(1). Make sure the instrumentation does not affect the signal to the dynamometer control circuits. Determine the speed error as follows:

(i) Set the dynamometer to speed-control mode. Set the dynamometer speed to a value of approximately 4.5 m/s (10 mph); record the output of the frequency counter after 10 seconds. Determine the roll speed, v_{act}, using the following equation:

$$x_{THCE} = x_{NOTHC} + \sum_{i=1}^{N}\left(x_{OHCi} - x_{OHCi\text{-}init}\right)$$

Eq. 1065.665-1

$$x_{NOTHC} = x_{THC[THC\text{-}FID]cor} - \sum_{i=1}^{N}\left(\left(x_{OHCi} - x_{OHCi\text{-}init}\right)\cdot RF_{OHCi[THC\text{-}FID]}\right)$$

Eq. 1065.665-2

$$x_{OHCi} = \frac{\frac{m_{dexhOHCi}}{M_{OHCi}}}{\frac{m_{dexh}}{M_{dexh}}} = \frac{n_{dexhOHCi}}{n_{dexh}}$$

Eq. 1065.665-3

Where:

f = frequency of the dynamometer speed sensing device, accurate to at least four significant figures.

d_{roll} = nominal roll diameter, accurate to the nearest 1.0 mm, consistent with §1066.225(d).

n = the number of pulses per revolution from the dynamometer roll speed sensor.

Example;

f = 2.9231 Hz = 2.9231 s^{-1}

d_{roll} = 904.40 mm = 0.90440 m

n = 1 pulse/rev

$$v_{act} = \frac{2.9231 \cdot 0.90440 \cdot \pi}{1}$$

$$v_{act} = 8.3053 \text{ m/s}$$

(ii) Repeat the steps in paragraph (c)(1)(i) of this section for the maximum speed expected during testing and at least two additional evenly spaced speed points between the starting speed and the maximum speed point.

(iii) Compare the calculated roll speed, v_{act}, to each corresponding speed set point, v_{ref}, to determine values for speed error at each set point, v_{error}, using the following equation:

$$v_{error} = v_{act} - v_{ref}$$

Eq. 1066.235-2

Example;
v_{act} = 8.3053 m/s
v_{ref} = 8.3000 m/s
v_{error} = 8.3053 − 8.3000 = 0.0053 m/s

(2) *Frequency method.* Install a piece of tape in the shape of an arrowhead on the surface of the dynamometer roll near the outer edge. Put a reference mark on the deck plate in line with the tape. Install a stroboscope or photo tachometer on the deck plate and direct the flash toward the tape on the roll. The stroboscope or photo tachometer must be calibrated according to the instrument manufacturer's instructions and be capable of measuring with enough accuracy to perform the procedure as specified in this paragraph (c)(2). Determine the speed error as follows:

(i) Set the dynamometer to speed-control mode. Set the dynamometer speed to a speed value of approximately 4.5 m/s (10 mph). Tune the stroboscope or photo tachometer until the signal matches the dynamometer roll speed. Record the frequency. Determine the roll speed, y_{act}, using Eq. 1066.235–1, using the stroboscope or photo tachometer's frequency for f.

(ii) Repeat the steps in paragraph (c)(2)(i) of this section for the maximum speed expected during testing and at least two additional evenly spaced speed points between the starting speed and the maximum speed point.

(iii) Compare the calculated roll speed, v_{act}, to each corresponding speed set point, v_{ref}, to determine values for speed error at each set point, y_{error}, using Eq. 1066.235–2.

(d) *Performance evaluation.* The speed error determined in paragraph (c) of this section may not exceed ±0.02 m/s at any speed set point.

§ 1066.240 Torque transducer verification.

Verify torque-measurement systems by performing the verifications described in §§ 1066.270 and 1066.275.

§ 1066.245 Response time verification.

(a) *Overview.* This section describes how to verify the dynamometer's response time to a step change in tractive force.

(b) *Scope and frequency.* Perform this verification upon initial installation, within 370 days before testing (i.e., annually), and after major maintenance.

(c) *Procedure.* Use the dynamometer's automated process to verify response time. You may perform this test either at two different inertia settings corresponding approximately to the minimum and maximum vehicle weights you expect to test or using base inertia and two acceleration rates that cover the range of acceleration rates experienced during testing (such as 0.5 and 8 mph/s). Use good engineering judgment to select road-load coefficients representing vehicles of the appropriate weight. Determine the dynamometer's settling response time, t_s, based on the point at which there are no measured results more than 10% above or below the final equilibrium value, as illustrated in Figure 1 of this section. The observed settling response time must be less than 100 milliseconds for each inertia setting.